ESO 1104

THE ECONOMIC VALUE OF GREAT LAKES SPORT FISHING: THE CASE OF PRIVATE-BOAT FISHING IN OHIO'S LAKE ERIE

by

Leroy J. Hushak
Jane M. Winslow
Nilima Dutta

July 1984

Department of Agricultural Economics & Rural Sociology
Ohio Agricultural Research and Development Center
Ohio Sea Grant
The Ohio State University

The Economic Value of Great Lakes Sport Fishing:
The Case of Private-Boat Fishing in Ohio's Lake Erie

In 1979, Talhelm et. al. (1979) estimated that sport anglers spent about $440 million for Great Lakes fishing, and attached a net economic value (consumers surplus) of about $525 million to fishing on the Great Lakes. At the same time, they called for additional research to provide better estimates of these values.

Lake Erie has historically produced about 50 percent of all fish harvested by sport and commercial fishermen from the Great Lakes. In Ohio, yellow perch has been an important species harvested by sport anglers for many years. Since 1975, with the return of large walleye populations to Lake Erie, a major recreation industry has grown around sport fishing for walleye during the May-August period. The creel census conducted by the Ohio Department of Natural Resources shows that angler hours for sport fishing increased from 7.5 million in 1975 to 13.6 million in 1982. Walleye harvested by sport anglers increased from 113,000 in 1975 to over 3 million in 1982. During the same period, yellow perch harvested increased from about 8 million to over 12 million (Status, 1983).

Since September, 1980, three studies have been undertaken to estimate how private-boat sport anglers value various components of Ohio's Lake Erie fishery: (1) western basin for May-August 15, 1981, called the walleye sample, (2) western basin for August 15-November, 1981, called the yellow perch sample, and (3) central basin for 1982. Excluded are anglers who hire the services of charter firms and shore anglers. Charter angler hours were less than ten percent of private-boat angler hours in 1981. The purpose of this paper is to present the results of these studies.

Descriptive statistics of each sample are presented in Table 1. For each sample, private-boat anglers were contacted at a launching or docking site and asked if they would be willing to complete the questionnaire for the study. If an angler was agreeable, we obtained his (her) name and address and mailed a questionnaire at the end of the fishing period (see Dutta, 1984 and Winslow, 1982 for a detailed description of sampling procedures). For the walleye sample, for example, the respondents were asked to report western basin fishing activity for May-August 15, 1981. A total of 648 anglers were contacted, of which 350 returned completed questionnaires (Table 1).

The mean age, income and group size for the three samples are similar. Nearly all respondents were male. The summer walleye sample travelled the greatest mean distance (86 miles), stayed the longest (1.8 days), and fished the longest (7.4 hours per day). The central basin sample made the largest number of trips (28.4) but were mainly local residents travelling an average of 16.8 miles to fish at a central basin site. In addition to fishing, central basin respondents were also asked to include recreational boating time and expenditures for non-fishing activities. The respondents reported spending 1.7 hours per day in recreational boating in addition to the 5.3 hours per

Table 1. Descriptive Statistics, by Sample

	Walleye 1981	Yellow Perch 1981	Central Basin 1982
<u>Sample Characteristics</u>			
Time Period	May-Aug. 15, 1981	Aug. 15-Nov., 1981	1982
Sample Size	648	550	730
Useable Responses	350	307	443
<u>Demographics</u> (sample means)			
Age (years)	43.6	45.7	44.5
Income ($)	26,516	24,362	24,295
Group size (no.)	3.1	2.8	3.2
<u>Fishing Effort</u> (sample means)			
Number of Trips	7.9	6.1	28.4
Days per Trip	1.8	1.7	1.1
Hours Fishing per Day	7.4	6.6	5.3
Distance Travelled (miles)	86.3	73.7	16.8
Number of Anglers	67,900	31,200	21,300
<u>Harvest Rates</u> (sample means per person per day)			
Walleye	2.3	0.9	.02
Yellow Perch	5.3	21.1	2.4
White Bass			0.6

day fishing.

Combining sample data and creel data, it is estimated that 67,900 anglers fished from Ohio sites during May-August 15, 1981. Accounting for overlap across samples it is estimated that 74,000 to 83,000 private-boat anglers fished in Ohio's portion of Lake Erie during 1981. The mean harvest per person per day was 2.3 walleye and 5.3 yellow perch in the walleye sample (Table 1).

The Recreation Demand Function

The recreation or travel cost demand methodology is used to estimate the value placed on sport fishing by private-boat anglers. The hedonic pricing model of McConnell (1979) and Bockstael and McConnell (1981) incorporates three relationships: a cost function, a quality function and a recreation demand function. Costs (total or per trip), quality of recreation experience, and number of recreation trips are the endogenous variables. In this form the model is nonlinear and difficult to estimate. Three assumptions allow simplification of the hedonic model to the single equation recreation or travel cost demand model. First, the quality of the recreation experience is assumed to be exogenous, or outside the direct control of the participant. Second, marginal cost per trip is assumed to be independent of the number of trips taken by individual re-creators. Third, trip length is exogenous (Bockstael and McConnell, 1981). Under these assumptions, the model reduces to

$$X = f\ (P_X,\ P_s,\ Q,\ INC) \tag{1}$$

where X is the number of recreation trips, P_x is the price per trip, P_s is the price to a substitute site, Q is quality of the recreation experience, and INC is income. The travel cost demand curve as the relation between number of trips and price per trip is illustrated in Figure 1.

Travel and On-Site Costs

In general, recreation costs can be divided into two categories: those incurred in transit, or travel costs; and those incurred on-site, or costs of participation. Travel costs consist of the costs of human time spent travelling to and from the site and the money costs of gas and oil, wear-and-tear on the vehicle, food, and other expenditures while in transit. As the basis of the hedonic pricing model, as well as its special case, the recreation demand model (Bockstael and McConnell, 1981 and McConnell, 1979), the logic behind the inclusion of costs of travel is that demand for a trip is a function of its price which is equal to the amount of resources a recreationist is willing to give up in exchange for a recreation trip. One way to approximate price is by the expenditures made by the angler in travelling to and from the site, i.e., travel costs. There is general agreement in the literature that both money and human time costs of travel should be included in estimates of travel costs.

On-site or participation costs are the human time costs of participation in the recreation experience and the money expenditures for entry fees, recreation equipment, on-site travel, food, and lodging. In several recreation demand studies, it is

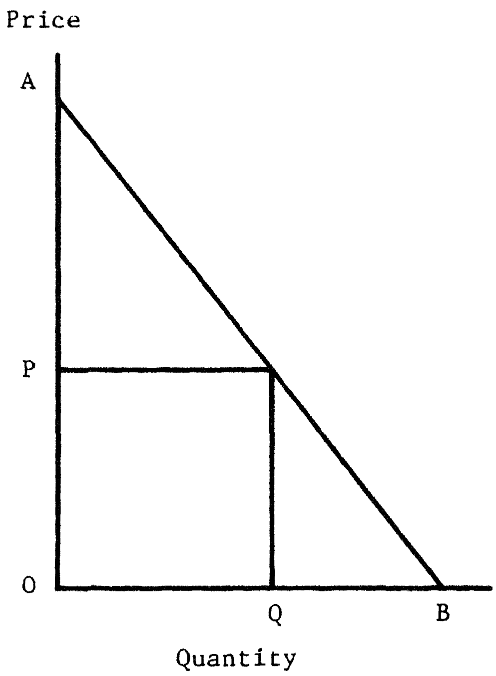

Figure 1. Demand curve

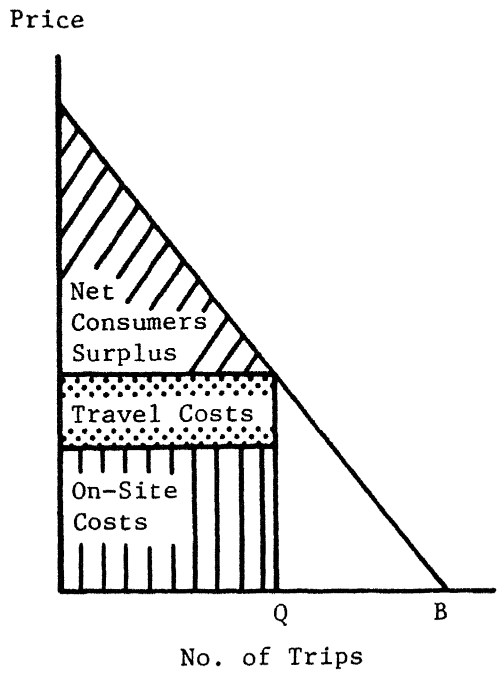

Figure 2. On-site costs, travel costs and net consumer surplus.

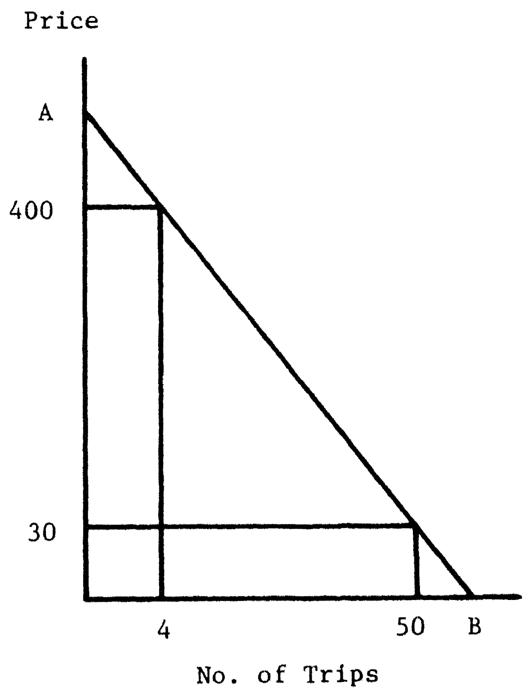

Figure 3. Effect of proximity to Lake Erie on costs and net consumers surplus

stated that data about on-site money (visit) costs needs to be obtained, but there is no subsequent discussion of how this data is to be incorporated into the demand model (e.g. Dwyer, Kelly and Bowes, 1977; Burt and Brewer, 1971; Mansfield, 1971; Cesario and Knetsch, 1976). In most studies on-site money costs are small and the major participation cost is the value of human time expended during the visit.

On-site costs are important on Lake Erie, especially for the walleye and yellow perch samples, because of significant trip length and of variation in trip length among participants. However, inclusion of on-site costs as part of trip prices (P_x, P_s) makes trip price endogenous and generates some estimation problems which have not been resolved. In this paper, only travel costs are included in trip prices and mean on-site costs are then added to price as a constant for computation of total willingness to pay (Figure 2).

Valuation of Time Costs

There is little concensus on how to value the human time component in travel or participation costs. Several other areas of research have also been forced to confront this issue. For example, in the valuation of a woman's time with respect to childbearing/rearing, time costs may outweigh money costs as a source of value. Pioneers in this field originally relied on the wage rate of full-time working women with similar skills and education levels to approximate the value of the mother's time (Gronau, 1973). Becker (1966) valued time at the individual's market wage rate in his development of the theory of the allocation of time. Yet it is possible, for a number of reasons, that the wage rate may not accurately represent the recreational opportunity cost of time to the individual.

McConnell (1975) concludes that there are three ways to value time expended in a recreational activity based on the best alternative activity foregone. Leisure time must be valued at the full working wage rate when the recreationist foregoes the opportunity to work in order to travel and participate in the recreational experience. When the option of working is not present, then time expended per recreational trip should be valued according to its value to the consumer in its next best leisure activity. Opportunity cost of travel and on-site time can only be ignored when the recreationist has no possibility of either taking on additional working hours or of participating in other recreational activities. Cesario (1976), Pollock and Wachter (1975) and Willman (1980) also discuss conceptual issues underlying the valuation of human time in recreation activities.

Cesario (1976) reviewed a series of studies of the opportunity cost of commuter time by transportation planners and found that time in transit is appropriately valued at less than the wage rate. From these studies, he tentatively concludes that travel time to the recreational site should be valued at 0.25 to 0.50 of the wage rate.

Bishop and Heberlien (1980) also argue that the opportunity cost of time is properly valued at less than the full wage rate. Recreationists include non-wage earning family members whose opportunity cost of time is expected to be lower than that of the wage-earning head of the household. Moreover, second-job, wage-earning opportunities are likely to be limited, either in terms of availability or level of compensation. As a result, they use 50 percent of income based on the upper estimate of the range suggested by Cesario. Others have chosen some variation of this linear tradeoff between time and money. Dwyer, Kelly, and Bowes (1977), for example, recommend the use of a fraction--"about one fourth to one-third is reasonable"--of the wage rate (p. 124). Cesario and Knetsch (1976) use one-third of the wage rate for adults, but only 25 percent of this adult level for children, i.e., 8.25 percent of the adult wage rate.

The valuation options are many and the literature does not point to any single method as best. In this paper several values for the opportunity cost of time are used: 50 percent, 25 percent and 0 percent of the wage rate.

Willingness to Pay

Total willingness to pay for sport fishing is derived from the demand curve estimates. Total willingness to pay is the total dollars a sport angler would be willing to spend for Lake Erie fishing rather than go without Lake Erie fishing (in this study for the respective components covered by each sample). Willingness to pay has three components: (1) the costs of travelling to and from the fishing site, (2) the on-site costs of fishing, (3) net consumers surplus (Figure 2). In this paper, only travel costs are used in determining the price of a fishing trip for estimation of the demand curve. The mean value of on-site costs (a constant) is then added to the price to locate the demand curve at the correct level.

Net consumer surplus is the triangular area above the price and below the demand curve in Figure 2. It is an estimate of the value of Lake Erie fishing to the private-boat sport angler over and above the economic costs (travel and on-site, money and human time). It is also an estimate of the annualized public investment justified by sport fishing. Net consumer surplus must be included in valuing the Lake Erie for two reasons. First, since the Lake Erie fishery is a unique resource, substitute fishing sites which are equally attractive cannot be established, i.e., only imperfect substitutes exist or can be developed. Second, since a significant component of fishing costs is travel costs, we would in many cases conclude that someone spending \$400 per trip for four trips per year (\$400 x 4), for example, values the Lake Erie fishery more highly than someone spending \$30 per trip for 50 trips per year (\$30 x 50), see Figure 3. This happens because much of the value of fishing to the angler who lives near the lake is captured without cost because of location near the lake.

Empirical Results

Equation (1) is estimated using an individual model in contrast to the more common zonal model. It is estimated in the form

(2) $$X = a_0 + a_1P_{wb} + a_2P_{cb} + a_3Q + a_4INC + e$$

where X is the number of angling trips made by the sample respondents, P_{wb} is the price of a trip to the western basin, P_{cb} is the price of a trip to the central basin, Q is the number of walleye or yellow perch kept per person per day in these respective samples (quality), INC is the midpoint of the income class (\$,000) as reported by the respondent, e is the random error, and a_i are parameters.

It is assumed that there are no substitutes for western basin walleye or yellow perch fishing, i.e., P_{cb} is excluded, for two reasons. First, the western basin is a unique resource for walleye and yellow perch fishing and there is probably nothing comparable to this resource, at least in the U.S. Second, to the extent that all anglers have access to local fishery resources at low cost, the price of a local fishery resource is approximately constant across anglers. At the same time, Q is excluded from the central basin equations because there is not a dominant species harvested by central basin anglers.

Several equations underlie the definitions of P_{wb} and P_{cb}. The vehicle cost of travel per one-way mile (VC) is

(3) $$VC = 2\ (\$0.15 + PGAS/MPG),$$

where two expresses round-trip distance in one-way distance, \$0.15 is the cost per mile of automobile ownership, maintenance, and oil, PGAS is the approximate price of gasoline per gallon which is equal to \$1.30 for the 1981 western basin samples and \$1.20 for the 1982 central basin sample, and MPG is the miles travelled per gallon of gasoline reported by sample respondents. Full costs of travel are incorportated, in contrast to variable costs in most studies, because many respondents own special vehicles to trailer boats in particular to the western basin and they travel significant numbers of miles for sport fishing.

On-site money expenditures (EXP) are composed of expenditures for fishing equipment, bait, food and beverages, lodging, boat ownership, and boating supplies of gas, oil, launching and docking fees, and repairs. Boat ownership costs are defined as

(4) $$BOC = 0.10\ (PRICE)(PROPOR)$$

where 0.10 is the opportunity cost of capital invested in the boat, PRICE is the price paid for the boat in 1981 dollars as adjusted by the Consumer Price Index, and PROPOR is the proportion of time respondents indicated their boat was used for western basin fishing during 1981. Boat ownership costs are included only in the on-site costs for the walleye sample because of the overlap of anglers across fisheries and the potential for double counting of these costs if included in the other samples.

The wage cost of travel per one-way mile (WCT) is

(5) $$WCT = (2 * INC)/(2000 * 50\ MPH),$$

where two converts round-trip miles to one-way miles, 2000 is hours worked per year (40 hours per week * 50 weeks) and 50 MPH is the assumed travel speed. The opportunity cost of travel is then 0.0, 0.25, or 0.50 of WCT. The wage cost per day on site (WCD) is

(6) $$WCD = (8 * INC)/2000,$$

where it is assumed that there are eight hours in a full work day. Other terms are as previously defined. The opportunity cost of a day on-site is then 0.0, 0.25, or 0.50 of WCD.

Trip prices are defined as

(7) $$P_{wb} \text{ or } P_{cb} = (VC/GS + bWCT)\ DIST$$

where b equals 0.0, 0.25 or 0.50, GS is group size of the fishing party reported by the respondents and DIST is one-way miles to the site measured as straight line distance from the county seat of the respondent to the fishing site. The corresponding definitions on-site costs are

(8) $$C_{.b} = EXP/GS + bWCD\ (DAYS)$$

where DAYS is the mean length of trip reported by respondents. The mean on-site costs are added to the total willingness to pay estimates, but are not included in the trip price variables.

Recreation Demand Estimates

Estimates of the recreation demand functions for all samples are presented in Table 2. All equations have significant F ratios at the 0.01 level. The R^2s are comparable to those of other studies. The variable INC is not significant in the two western basin equations where the human cost of time estimate is zero and was excluded from the central basin equation because it was not significant; it is dropped from the remaining equations because it is included in the estimation of the opportunity cost of human time.

In equation P.0 for walleye, the coefficient for P_{wb} of -0.122 means that a $1.00 increase in the price of a trip results in 0.122 fewer trips taken. Each unit increase in the walleye harvest rate (Q) results in 0.423 more trips taken. The coefficients of Q for yellow perch were negative and not statistically significant.

Table 2. Recreation Demand Function Estimates

Equation	P_{wb}	P_{cb}	Q	INC	Intercept	R^2	F
Western Basin Walleye (N = 312)							
P .0	-0.122 (4.919) [-0.289]		0.423 (3.378)	0.002 (0.090)	9.17	0.084	9.38*
P .25	-0.097 (6.118) [-0.380]		0.390 (3.276)		10.02	0.117	20.37*
P .50	-0.068 (6.176) [-0.372]		0.344 (2.935)		10.06	0.118	20.73*
Western Basin Yellow Perch (N = 307)							
P .0	-0.085 (3.921) [-0.256]		-0.006 (0.495)	0.000 (0.058)	7.99	0.065	5.94*
P .25	-0.072 (4.523) [-0.323]		-0.009 (0.690)		8.42	0.080	11.29*
P .50	-0.056 (4.611) [-0.335]		-0.011 (0.896)		8.55	0.083	11.70*
Central Basin (N = 395)							
P .0	0.60 (3.29)	-2.66 (5.48) [-0.253]			37.45	0.069	15.49*
P .25	0.20 (1.64)	-1.31 (5.22) [-0.225]			36.51	0.68	14.26*
P .50	0.12 (1.50)	-0.85 (5.02) [-0.172]			35.98	0.65	13.73*

Notes: t-ratios are in parentheses; point elasticities at the mean are in brackets.

*F-ratio significant at the 0.01 level.

The coefficients of P_{wb} and P_{cb} cannot be directly compared because the scale is different in each equation. The own-price point elasticities at the mean are more comparable. In the western basin samples, the own-price point elasticities are greater in magnitude when human time is incorporated at 0.25 or 0.50 of the wage cost as compared to zero cost, while they are smaller is the central basin sample. In all cases, the point elasticities are highly inelastic (less than one in magnitude), which implies that an increase in price generates less than proportionate reductions in the number of trips.

The central basin data were also disaggregated to allow estimation of recreation demand equations for four alternative sites or site areas in the central basin: Lorain Harbor, Cleveland, Grand River and Ashtabula county. The "best" results are presented in Table 3. The western basin was the strongest substitute site only for the Cleveland area. For Lorain Harbor, however, there was high colinearity between P_2 and P_{wb}. The own-price point elasticity at the mean for Ashtabula is about -1.0. These estimates are used for the computation of total willingess to pay for the central basin rather than those in Table 2 because they incorporate substitution among central basin sites.

Willingness to Pay

Estimates of total willingness to pay and each of its components for western basin walleye, western basin yellow perch and the central basin are presented in Tables 4, 5 and 6, respectively. Each table contains estimates with human time

Table 3. Disaggregated Recreation Demand Function Estimates for the Central Basin

Equation	P_1	P_2	P_3	P_4	P_{wb}	Intercept	R^2	F
Lorain Harbor (N = 130)								
P 1.0	-3.96 (4.51) [-0.386]	2.61 (3.27)				34.10	0.130	10.26*
P 1.25	-2.30 (4.31) [-0.383]	1.74 (3.39)				34.68	0.127	9.29*
P 1.50	-1.56 (4.22) [-0.369]	1.22 (3.40)				34.38	0.122	8.90*
Cleveland (N = 142)								
P 2.0		-2.64 (4.15) [-0.811]			0.52 (1.94)	24.77	0.116	10.13*
P 2.25		-1.62 (4.09) [-0.852]			0.27 (1.49)	23.83	0.131	10.51*
P 2.50		-1.11 (4.10) [-0.828]			0.18 (1.53)	23.62	0.130	10.47*
Grand River (N = 173)								
P 3.0			-4.41 (3.85) [-0.376]	1.24 (1.75)		29.36	0.078	7.62*
P 3.25			-2.30 (3.69) [-0.367]	0.43 (1.01)		28.16	0.086	8.03*
P 3.50			-1.57 (3.60) [-0.362]	0.28 (1.00)		27.96	0.084	7.80*
Ashtabula (N = 156)								
P 4.0			2.73 (4.98)	-3.61 (7.40 [-0.996]		40.57	0.269	29.49*
P 4.25			1.49 (4.70)	-2.19 (8.14) [-1.126]		42.28	0.302	33.18*
P 4.50			1.05 (4.80)	-1.43 (7.89) [-1.069]		41.26	0.289	31.20*

Notes: t-ratios are in parentheses; point elasticities at the mean are in brackets
*F-ratio significant at the 0.01 level.

valued at zero, 25 and 50 percent of the wage rate, where the estimates are stated per trip, per day and for the appropriate aggregation over angler hours from the Ohio Department of Natural Resources creel surveys.

In Table 4, western basin walleye respondents incurred average money travel costs of $15.28 per trip (with human time valued at zero). With human time valued at 25 percent of the wage rate, travel costs averaged $21.62 per angler; and averaged $34.88 when human time was valued at 50 percent of the wage rate. Money on-site costs had a mean value of $69.60, with human time valued at zero. Net consumer surplus increases from $33.98 when human time is valued at zero to $62.06 when human time is valued at 50 percent of the wage rate. The summation of travel costs, on-site costs and net consumer surplus yields total willingness to pay estimates of $118.85, $178.30 and $262.00 per trip when human time is valued at zero, 25 and 50 percent of the wage rate, respectively.

The per day estimates in Table 4 are equal to the per trip estimates divided by 1.8 days per trip (Table 1). When the value of human time is 25 percent of the wage rate, average total willingness to pay is $96.80 per day, while net consumer surplus (the amount anglers are willing to pay over and above expenditures) is $21.18 per day. Creel data from the Ohio Department of Natural Resources were used to estimate the aggregate western basin walleye willingness to pay. Total western basin angler hours for May-August, 1981 from the creel census were 8.0 million. Division of angler hours by the sample mean of 7.4

Table 4. Estimated Expenditures, Net Consumer Surplus and Total Willingness to Pay per Person, Western Basin Walleye, 1981.

	Human Time as % of Wage Rate		
	0	25	50
Per Trip			
Number of Trips	7.95	7.95	7.95
Travel Costs ($)	15.28	21.62	34.88
On-Site Costs ($)	69.60	117.33	165.06
Net Consumer Surplus ($)	33.98	39.35	62.06
Willingness to Pay ($)	118.85	178.30	262.00
Per Day			
Travel Costs ($)	8.22	12.58	20.97
On-Site Costs ($)	37.46	63.98	90.49
Net Consumer Surplus ($)	18.29	21.18	33.40
Willingness to Pay ($)	63.97	96.80	142.66
Aggregate Western Basin Walleye, May-August, 1981			
Travel Costs ($ Mil.)	8.89	12.58	20.97
On-Site Costs ($ Mil.)	40.50	69.16	97.83
Net Consumer Surplus ($ Mil.)	19.77	22.90	36.11
Willingness to Pay ($ Mil.)	69.16	104.64	154.91

hours fishing per day (Table 1) yields a total of 1,081,075 angler days. Multiplication of the per day estimates of travel costs, on-site costs, net consumer surplus, and willingness to pay by western basin angler days yields the aggregated estimates. The total willingness to pay for, or the total value placed on, western basin summer (walleye) fishing over the May-August, 1981 period was \$69.16 million, \$104.64 million, or \$154.91 million when human time was valued at zero, 25, or 50 percent of the respondents' wage rates, respectively. The net consumer surplus of \$22.9 million is the amount by which sport anglers value western basin walleye fishing over and above expenditures.

The estimates for yellow perch fishing for autumn, 1981 are presented in Table 5. The per trip and per day estimated values for yellow perch are quite similar to those for the walleye data in Table 4. The aggregate estimates for September-October, 1981 are much less because there are many fewer angler hours during the autumn period. For September-October, 1981, 1.3 million angler hours are reported in the creel census. Division of angler hours by 6.6 hours fishing per day (Table 1) yields an estimated 202,130 angler days. Multiplication of angler days by the per day estimates of travel costs, on-site costs, net consumer surplus, and willingness to pay yields the aggregate western basin yellow perch estimates. Total willingness to pay for western basin autumn (yellow perch) fishing by private-boat anglers is \$13.13 million, \$19.71 million, or \$27.13 million, when human time is valued at zero, 25, or 50 percent of the wage rate, respectively.

Table 5. Estimated Expenditures, Net Consumer Surplus and Total Willingness to Pay per Person, Western Basin Yellow Perch, 1981.

	Human Time as % of Wage Rate		
	0	25	50
Per Trip			
Number of Trips	6.26	6.26	6.26
Travel Costs ($)	15.70	23.07	31.01
On-Site Costs ($)	55.49	96.90	138.32
Net Consumer Surplus ($)	39.24	45.86	58.77
Willingness to Pay ($)	110.43	165.83	228.10
Per Day			
Travel Costs ($)	9.24	13.57	18.24
On-Site Costs ($)	32.64	57.00	81.36
Net Consumer Surplus ($)	23.09	26.98	34.57
Willingness to Pay ($)	64.96	97.55	134.17
Aggregate Western Basin Yellow Perch, Sept.-Oct., 1981			
Travel Costs ($ Mil.)	1.87	2.74	3.69
On-Site Costs ($ Mil.)	6.60	11.52	16.45
Net Consumer Surplus ($ Mil.)	4.67	5.45	6.99
Willingness to Pay ($ Mil.)	13.13	19.71	27.12

In Table 6, estimates of travel costs, on-site costs, net consumer surplus and total willingness to pay by private-boat anglers in the central basin for 1982 are presented. These estimates, which include recreational boating activities other than fishing are calculated as weighted averages of the dis-aggregated demand estimates in Table 3. In contrast to the western basin, the central basin fishery attracts primarily local residents who travel relatively short distances to fishing sites for single day trips. Total willingness to pay per day ranges from 30 to 60 percent of the willingness to pay for western basin walleye or yellow perch fishing. Net consumer surplus is estimated at $4 per day.

The aggregate central basin willingess to pay is estimated at $7.41 million, $18.85 million or $30.40 million when human time is valued at zero, 25, or 50 percent of the wage rate, respectively. These estimates are based on 1982 creel census report of 2.1 million angler hours divided by 5.3 hours fishing per day (Table 1) which yields 396,226 angler days. These values overestimate the willingness to pay for the central basin fishery because they include non-fishing activities. Whether they over or underestimate the value of total recreational boating depends on whether recreational boating other than fishing is over or underrepresented in the sample.

Conclusion

If we sum the aggregate total willingness to pay estimates for three fishery components, the total willingness to pay is $89.7 million when human time is valued at zero percent of the

Table 6. Estimated Expenditures, Net Consumer Surplus and Total Willingness to Pay per Person, Central Basin, 1982

	Human Time as % of Wage Rate		
	0	25	50
Per Trip			
Number of Trips	28.4	28.4	28.4
Travel Costs ($)	3.40	6.04	8.72
On-Site Costs ($)	15.06	43.14	71.21
Net Consumer Surplus ($)	2.68	4.58	6.79
Willingness to Pay ($)	21.14	53.76	86.72
Per Day			
Travel Costs ($)	3.01	5.35	7.71
On-Site Costs ($)	13.33	38.13	63.02
Net Consumer Surplus ($)	2.37	4.05	6.00
Willingness to Pay ($)	18.71	47.53	76.73
Aggregate Central Basin, 1982			
Travel Costs ($ Mil.)	1.19	2.12	3.05
On-Site Costs ($ Mil.)	5.28	15.13	24.97
Net Consumer Surplus ($ Mil.)	.94	1.60	2.38
Willingness to Pay ($ Mil.)	7.41	18.85	30.40

wage rate, $143.2 million at 25 percent and $212.4 million at 50 percent. If we adjust the central basin estimates to reflect the 1.6 million angler hours estimated for 1981 rather than the 2.1 million for 1982, the respective estimates are $87.9 million, $138.7 million and $205.2 million, an estimate which uses 1981 creel census data in total. While it is not possible to make a precise estimate, it appears that these components of the Lake Erie fishery, over 90 percent of the 1981 angler hours reported by the creel census, were valued by sport anglers at $140 million to $200 million in 1981.

In generating these values, private-boat sport anglers made total money expenditures estimated at $64.3 million (the sum of travel and on-site costs from column one of Tables 4, 5, and 6). The balance of the value of Lake Erie sport fishing is composed of the value of human time and net consumer surplus. The estimate of net consumer surplus indicates the amount of annualized public investment which is justified because it is value in addition to costs incurred. Walleye and yellow perch fishing in the western basin generated net consumer surplus of over $28 million in 1981 as compared to less than $2 million in the central basin. This contrast is due to large differences in angler hours and in net consumer surplus estimates in excess of $20 per day in the western basin as compared to about $4 per day in the central basin. Much larger public investments in the central basin can be justified if the investments raise the quality of fishing to a level comparable to that in the western basin.

REFERENCES

Becker, Gary S. 1965. "A Theory of the Allocation of Time." Economic Journal 5 (September): 493-517.

Bishop, Richard C. and Thomas A. Heberlein. 1980. "Simulated Markets, Hypothetical Markets, and Travel Cost Analysis: Alternative Methods of Estimating Outdoor Recreation Demand." Staff Paper 187, Department of Agricultural Economics, University of Wisconsin, December.

Bockstael, Nancy and Kenneth E. McConnell. 1981. "Theory and Estimation of the Household Production Function for Wildlife Recreation." Journal of Environmental Economics and Management 8 (September): 199-214.

Burt, Oscar R. and Durward Brewer. 1971. "Estimation of Net Social Benefits from Outdoor Recreation." Econometrica 39 (September): 813-827.

Cesario, F. J. and J. L. Knetsch. 1976. "A Recreation Site Demand and Benefit Estimation Model." Regional Studies 10 (March): 97-104.

Cesario, Frank J. 1976. "Value of Time in Recreation Benefit Studies." Land Economics 52 (February): 32-41.

Dutta, Nilima. 1984. "The Value of Recreational Boating and Fishing in the Central Basin of Ohio's Portion of Lake Erie." Unpublished M.S. Thesis, The Ohio State University.

Dwyer, John F., John R. Kelly and Michael O. Bowes. 1977. Improved Procedures for Valuation of the Contribution of Recreation to National Economic Development. Water Resources Center, University of Illinois at Urbana-Champaign, September.

Gronau, Reuben. 1973. "The Effect of Children on the Housewife's Value of Time." Journal of Political Economy 81 (March): S168-199.

Mansfield, N. W. 1971. "The Estimation of Benefits from Recreation Sites and the Provision of a New Recreation Facility." Regional Studies 5 (July): 55-69.

McConnell, Kenneth E. 1975. "Some Problems in Estimating the Demand for Outdoor Recreation." American Journal of Agricultural Economics 57 (May): 330-334.

McConnell, Kenneth E. 1979. "Values of Marine Recreational Fishing: Measurement and Impact of Measurement." American Journal of Agricultural Economics 61 (December): 921-925.

Pollak, Robert A. and Michal L. Wachter. 1975. "The Relevance of the Household Production Function and Its Implications for the Allocation of Time." Journal of Political Economy 83 (April): 255-277.

"Status of Ohio's Lake Erie Fisheries." Various Years. Ohio Department of Natural Resources, Division of Wildlife.

Talhelm, Daniel P., Richard C. Bishop, Kenneth W. Cox, Norman W. Smith, Donald N. Steinnes, and Archibold L. W. Tuomi. 1979. "Current Estimates of Great Lakes Fisheries Values: 1979 Status Report." Great Lakes Fishery Commission, Ann Arbor, Michigan.

Wilman, Elizabeth A. 1980. "The Value of Time in Recreation Benefit Studies." Journal of Environmental Economics and Management 7 (September): 272-286.

Winslow, Jane Marie. 1982. "Private-Boat Walleye Angling in the Ohio Waters of Lake Erie: An Economic Evaluation." Unpublished M.S. Thesis, The Ohio State University.